MULTIMEDIA UNIVERSITY

STUDENT ID NO

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 3, 2015/2016

EEE 3096 – COMMUNICATION ELECTRONICS
(TE, MCE)

1 JUNE 2016
9:00 A.M. – 11:00 A.M.
(2 Hours)

INSTRUCTIONS TO STUDENTS

1. This Question paper consists of 7 pages with 4 Questions only .
2. Attempt **ALL FOUR** questions .
3. Please print all your answers in the Answer Booklet provided.

Question 1

(a) With the aids of circuit diagram, list out three types of attenuators.

[6 marks]

(b) In an electrical circuit, when resonance occurs, what can be said about the impedance of a series circuit and a parallel circuit?

[2 marks]

(c) Consider the RLC network shown in Figure Q1. The values of the components used are R = 10kΩ, C = 13 pF and L = 20 μH.

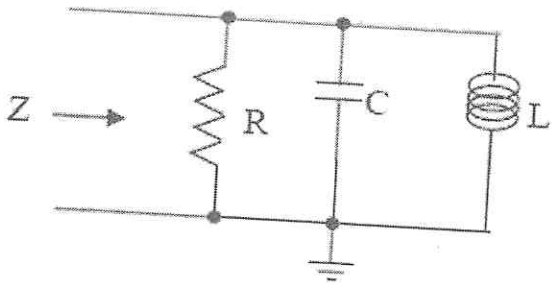

Figure Q1

(i) Determine the resonant frequency and bandwidth of the circuit.

[6 marks]

(ii) If the resonant frequency is to be increased by 10%, which of the RLC components need to be increased or reduced and by how much?

[5 marks]

(iii) Discuss the effect of the increase or reduction of the components in part (ii) above on the overall bandwidth of the RLC circuit.

[6 marks]

Continued...

Question 2

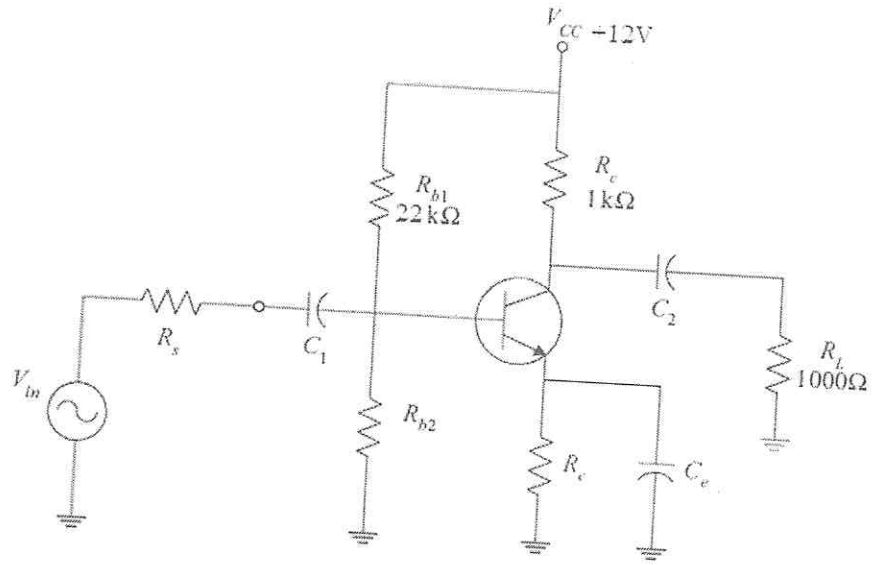

Figure Q2

An amplifier circuit is shown in Figure Q2. For this amplifier, it is given that r_{ce} = 15 kΩ, $r_{bb'}$ = 30 Ω, $r_{b'e}$ = 1.5 kΩ, I_c = 3.8mA and $V_{ce} = 0.5058V_{cc}$.

(a) Draw the DC equivalent circuit of the amplifier. [5 marks]

(b) Is this a common base, common collector or common emitter configuration? Explain your answer. [2 marks]

(c) Perform the dc analysis to find R_{b2} and R_e. [10 marks]

(d) Draw the equivalent hybrid-Π model of the circuit. [4 marks]

(e) Determine the input resistance looking from the source network and the output resistance looking into the output pin. [4 marks]

Continued...

Question 3

(a) With the aid of suitable diagram, explain the capture range and lock range of a phase lock loop (PLL)?

[7 marks]

(b) A PLL with a voltage controlled oscillator (VCO) free-running frequency of 5 MHz has a 15% capture range and a 30% lock range. Over what frequency will the PLL able to capture and subsequently maintain lock?

[4 marks]

(c) Design a PLL frequency synthesizer that will cover a range of 144 to 148 MHz in 5 kHz steps, starting at 144 MHz. Assume that the reference oscillator is at 5 MHz the M divider is fixed at some value, and that the N divider is programmable, so that the synthesizer will cover the desired range.

(i) Sketch a diagram of your design, indicating the frequencies present at various points of the diagram.

[5 marks]

(ii) Determine the value N of the programmable divider.

[5 marks]

(d) List out four advantages of performing loop compensation in phase lock loop (PLL).

[4 marks]

Continued...

Question 4

(a) A monochrome television (TV) channel was allocated a 6 MHz bandwidth. Using suitable diagrams, explain how chrominance information is fitted into the same 6 MHz bandwidth for colour TV transmission and why it is possible.

[7 marks]

(b) List out four advantages of performing loop compensation in phase lock loop (PLL).

[4 marks]

(c) Using cathode-ray-tube (CRT) display as an example, describe how contrast control and brightness control can be achieved in television (TV) receiver. Your answer should include the meaning of the terms "contrast" and "brightness", how they are encoded in TV signals, and how they can be controlled or tuned.

[6 marks]

(d)

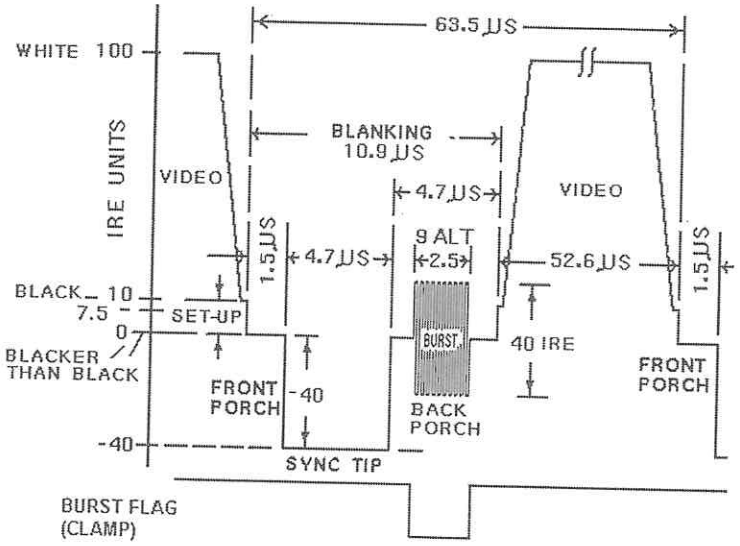

Figure Q4

NTSC TV standard defines a frame rate of 30 fps with 525 lines per frame, a luminance video bandwidth of 4.2 MHz, and an aspect ratio of 4:3. Figure Q4 shows a typical horizontal line of NTSC TV video signal. Determine the following:

(i) the field and line frequency, and

[3 marks]

(ii) the luminance horizontal resolution per picture height.

[5 marks]

End of Paper

Appendix – Useful Formulas

1. L impedance matching network (when $R_L > R_S$):

$$B = \frac{X_L \pm \sqrt{R_L / R_s}\sqrt{R_L{}^2 + X_L{}^2 - R_s R_L}}{R_L{}^2 + X_L{}^2} \qquad X = \frac{1}{B} + \frac{X_L R_s}{R_L} - \frac{R_s}{B R_L}$$

$$Q = \frac{|X|}{R_S}$$

2. L impedance matching network (when $R_L < R_S$):

$$B = \pm\frac{\sqrt{(R_s - R_L)/R_L}}{R_s} \qquad X = \pm\sqrt{R_L(R_s - R_L)} - X_L \qquad Q = R_S|B|$$

3. π impedance matching network:

$$L = L_1 + L_2 = \frac{R_I}{\omega_o}\left(\sqrt{R_S / R_I - 1} + \sqrt{R_L / R_I - 1}\right)$$

$$C_1 = \frac{1}{\omega_o R_S}\sqrt{\frac{R_S}{R_I} - 1} \qquad C_2 = \frac{1}{\omega_o R_L}\sqrt{\frac{R_L}{R_I} - 1} \qquad Q = \sqrt{\frac{R_S}{R_I} - 1} + \sqrt{\frac{R_L}{R_I} - 1}$$

4. RF Class A transistor amplifier (Hybrid π model of BJT)

$r_{bb'}$	**The base-spreading resistance.**
g_m	**The transconductance.** $g_m = \frac{dI_C}{dV_{BE}} = \frac{qI_C}{kT} \cong \frac{I_C(\text{in mA})}{25.875mV}$ at T=300K, q= electronic charge, $1.6\text{x}10^{-19}$C
C_e	**The emitter capacitance.**
$r_{b'e}$	**The input resistance.** $r_{b'e} = \frac{dV_{B'E}}{dI_B} = \frac{h_{fe}}{g_m}$
$r_{b'c}$	**The collector to base resistance.** $r_{b'c} = h_{fe} r_{ce}$
C_C	**The collector capacitance.**
r_{ce}	**The output resistance.** $r_{ce} \cong \frac{V_A}{I_C} = \frac{qV_A}{kTg_m}$ Where V_A is known as the Early voltage and I_C is the dc collector current.

5. High frequency Class A amplifier parameters:

(a) Voltage gain:

$$A_V = \frac{v_o}{v_{BE}} = -g_m R_o \frac{r_{b'e}}{r_{bb'} + r_{b'e}} \frac{1}{1 + j\omega C_T \frac{r_{bb'} r_{b'e}}{r_{bb'} + r_{b'e}}}$$

In cases where $r_{bb'} << r_{b'e}$ then

$$A_V = \frac{v_o}{v_{BE}} = -\frac{g_m R_o}{1 + j\omega C_T r_{bb'}}$$

(b) Effective voltage gain (including the effect of source impedance R_S):

$$A_{VS} = \frac{v_o}{V_S} = -g_m R_o \frac{r_{b'e}}{r_{bb'} + R_S + r_{b'e}} \frac{1}{1 + j\omega C_T \frac{(R_S + r_{bb'}) r_{b'e}}{R_S + r_{bb'} + r_{b'e}}}$$

In cases where $(R_s + r_{bb'}) << r_{b'e}$ then

$$A_{VS} = \frac{v_o}{V_S} = -\frac{g_m R_o}{1 + j\omega C_T (R_S + r_{bb'})}$$

Where $C_T = C_e + C_M$ and C_M = Miller capacitance $C_M = (1 + g_m R_o) C_C$

(c) Transition frequency

$$f_T = \frac{1}{2\pi} \frac{g_m}{C_e + C_C}$$

(d) Input impedance

$$Z_I = r_{bb'} + \frac{r_{b'e}}{1 + j\omega r_{b'e} C_T}$$